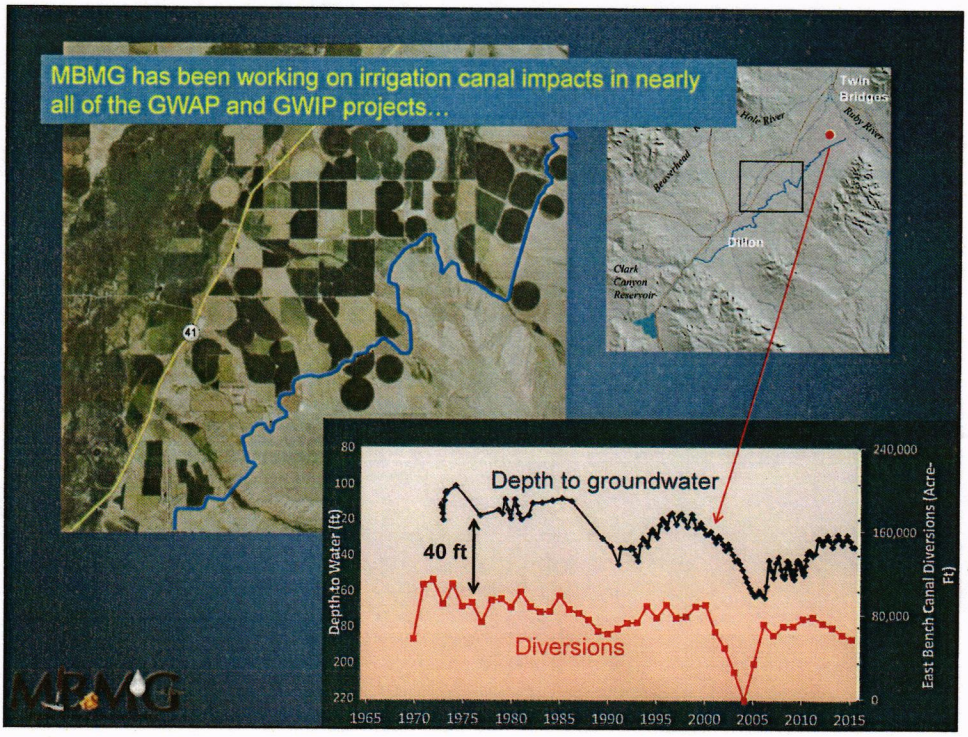
MBMG

Montana Bureau of Mines and Geology

Study of Farmers Canal

Water Policy Interim Committee
January 7, 2020

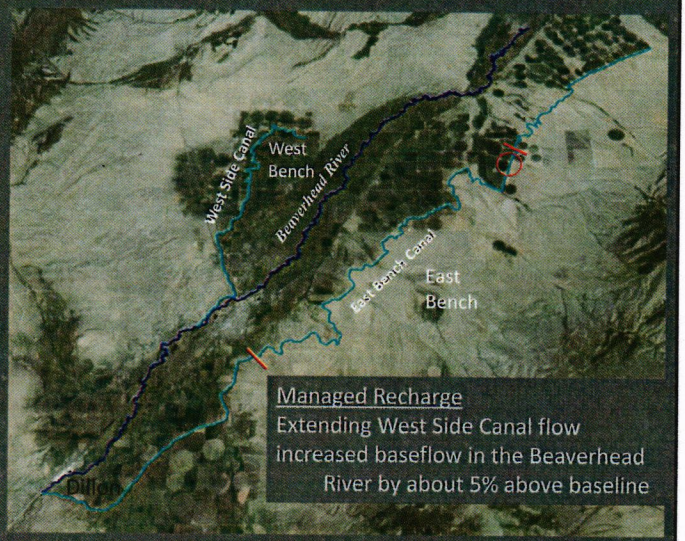
John Metesh
Montana Bureau of Mines and Geology



East Bench and West Side Canals

Average leakage....

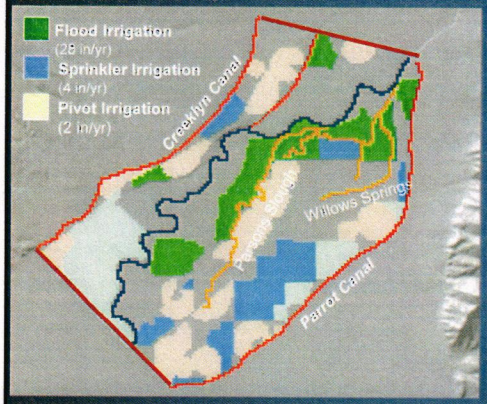
2.2 cfs/mile and 1.1 cfs/mile



Managed Recharge
Extending West Side Canal flow increased baseflow in the Beaverhead River by about 5% above baseline

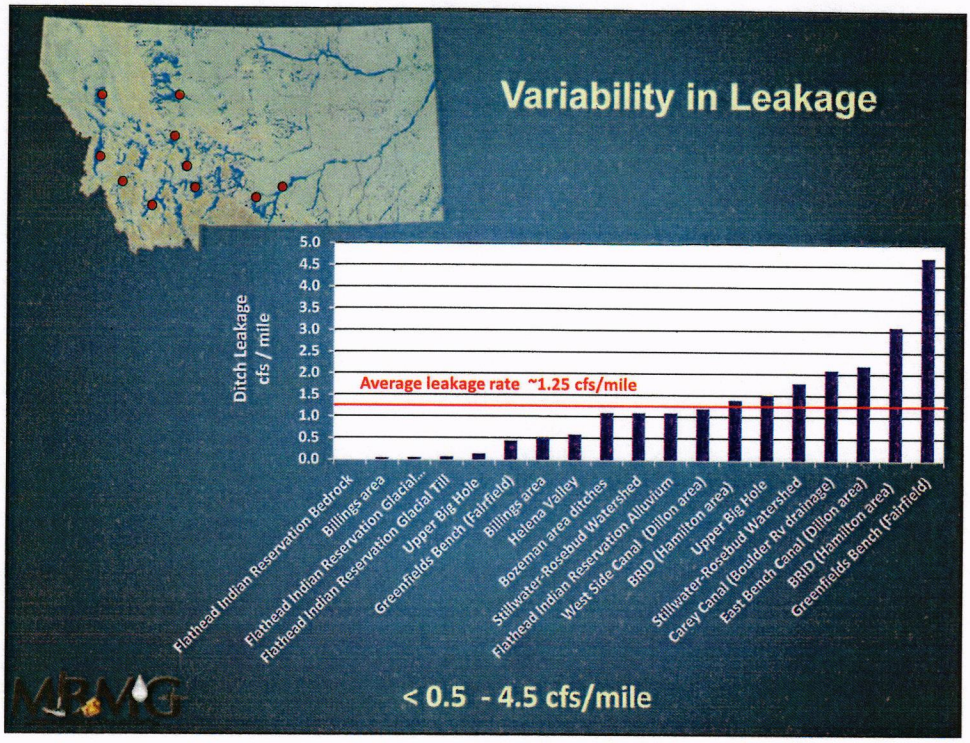
MBMG

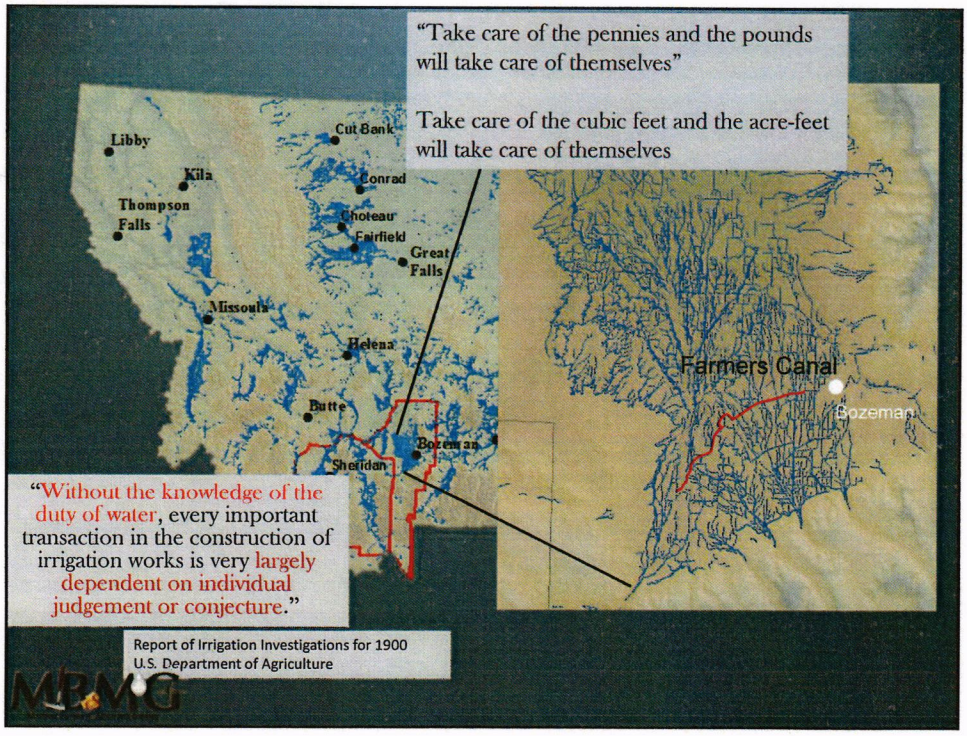
Jefferson Valley



changes in irrigation management related to volume and/or change the timing of groundwater flow

MBMG


Variability in Leakage
Ditch Leakage cfs / mile
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Average leakage rate ~1.25 cfs/mile
Flathead Indian Reservation Bedrock
Billings area
Flathead Indian Reservation Glacial...
Flathead Indian Reservation Glacial Till
Upper Big Hole
Greenfields Bench (Fairfield)
Billings area
Helena Valley
Bozeman area ditches
Stillwater-Rosebud Watershed
Flathead Indian Reservation Alluvium
West Side Canal (Dillon area)
BRID (Hamilton area)
Upper Big Hole
Stillwater-Rosebud Watershed
Carey Canal (Boulder Rv drainage)
East Bench Canal (Dillon area)
BRID (Hamilton area)
Greenfields Bench (Fairfield)
< 0.5 - 4.5 cfs/mile


"Take care of the pennies and the pounds will take care of themselves"
Take care of the cubic feet and the acre-feet will take care of themselves
Libby
Kila
Thompson Falls
Cut Bank
Conrad
Choteau
Fairfield
Great Falls
Missoula
Helena
Butte
Bozeman
Sheridan
Farmers Canal
Bozeman
"Without the knowledge of the duty of water, every important transaction in the construction of irrigation works is very largely dependent on individual judgement or conjecture."
Report of Irrigation Investigations for 1900
U.S. Department of Agriculture

BACKGROUND

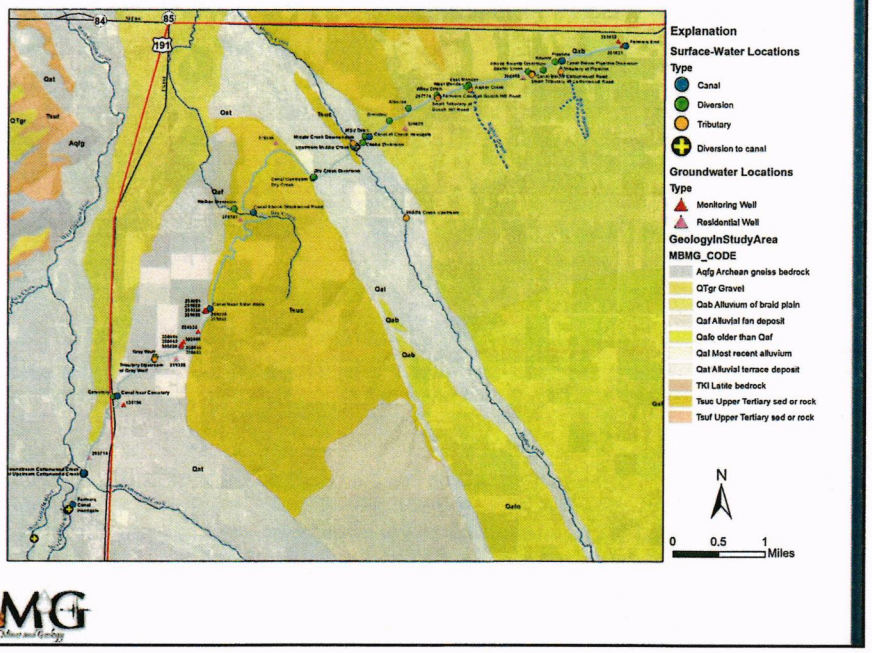
Farmers Canal

- Built in 1890
- 10 miles
- Services more than 14,000 acres
- Source: West Gallatin River near Gallatin Gateway
- Canal is equipped with weirs/flumes on nearly all its diversions/head gates

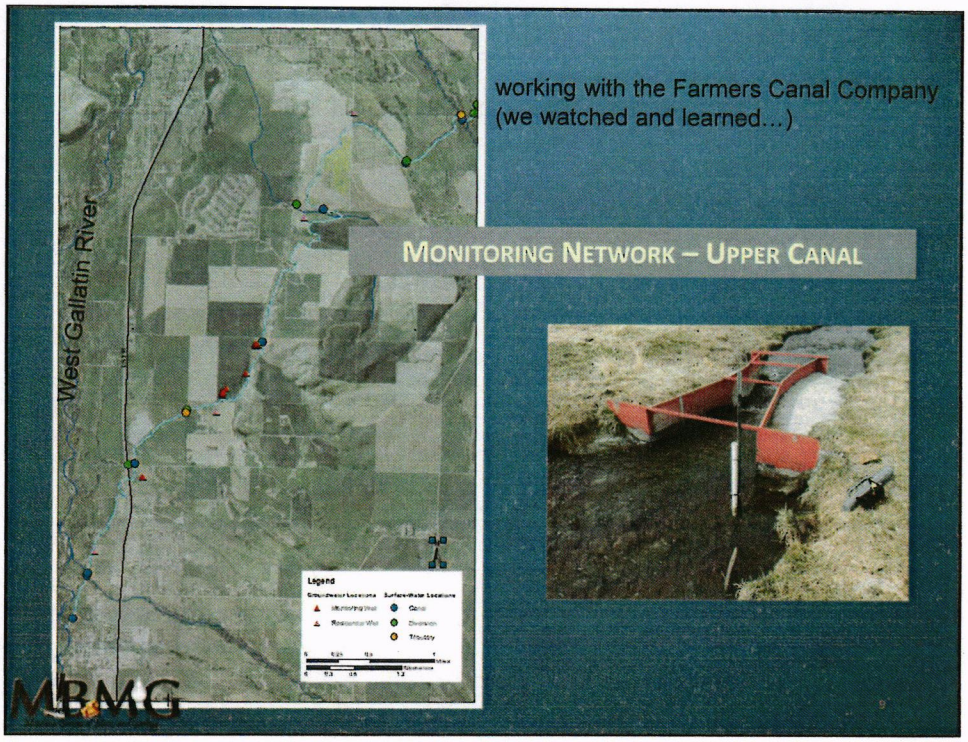
Purpose

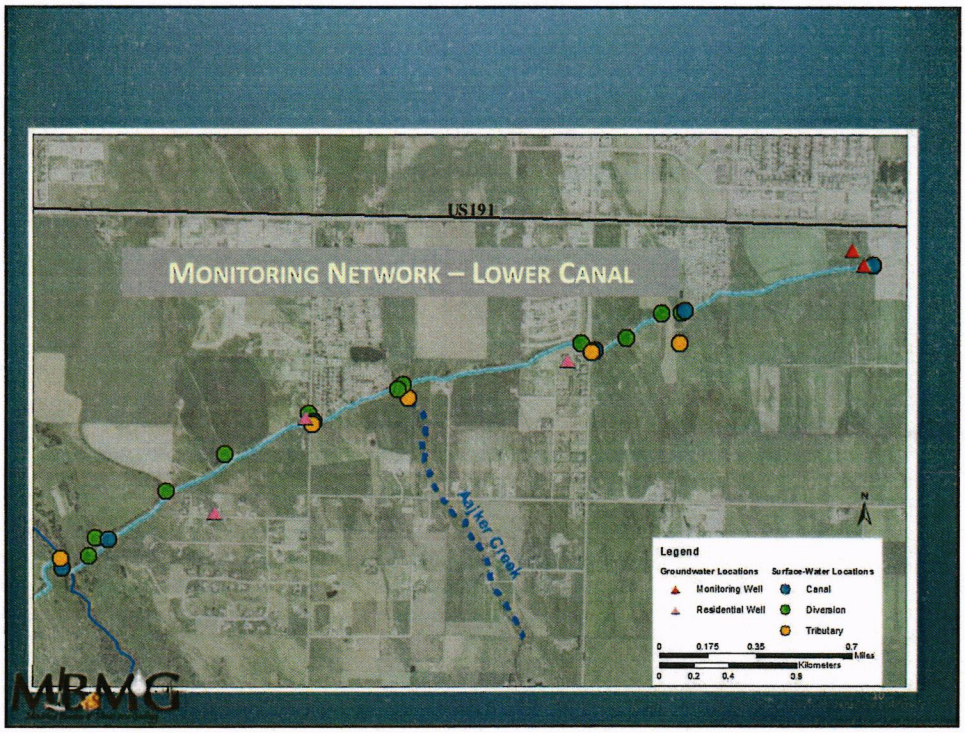
- Department of the Interior, Bureau of Reclamation Great Plains Region, Montana Area Office
  - Water Conservation Field Services Program
    - Water Management and Conservation Planning Grant
- **Design water management options to improve canal efficiency**
  - **consider unintended consequences (eg groundwater recharge)**
- $100,000 with cost share

MBMG



MBMG


working with the Farmers Canal Company
(we watched and learned…)
MONITORING NETWORK – UPPER CANAL
West Gallatin River
Legend
Groundwater Locations
Surface-Water Locations
Monitoring Well
Residential Well
Canal
Diversion
Tributary
MBMG

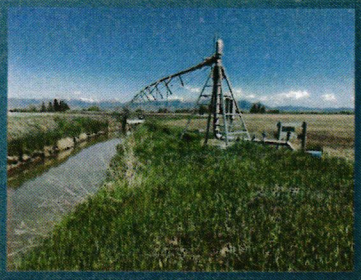

US191
MONITORING NETWORK – LOWER CANAL
Walker Creek
N
Legend
Groundwater Locations
Surface-Water Locations
Monitoring Well
Residential Well
Canal
Diversion
Tributary
0 0.175 0.35 0.7 Miles
0 0.2 0.4 0.8 Kilometers
MBMG

Data Collection

Surface-water Data (25 sites)

- Canal sites – Stage and discharge for rating curves (13 sites)
- Flume sites – recorded stage (15 sites)
- Tributaries – Stage and discharge for rating curves (6 sites)

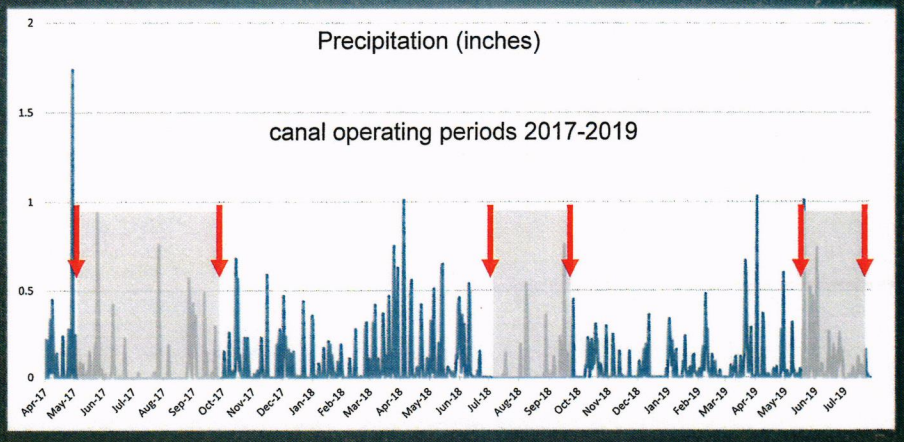
- Chemistry Data (pre, during, & post-irrigation)
  - Nitrates
  - Major cations/ions
  - Isotopes



Groundwater Data (21 Wells)

- Groundwater levels from wells near the canal
  - 13 Monitoring wells
  - 8 Residential wells
- Chemistry Data (pre, during, & post-irrigation)
  - Nitrates
  - Major cations/ions
  - Isotopes

MBMG

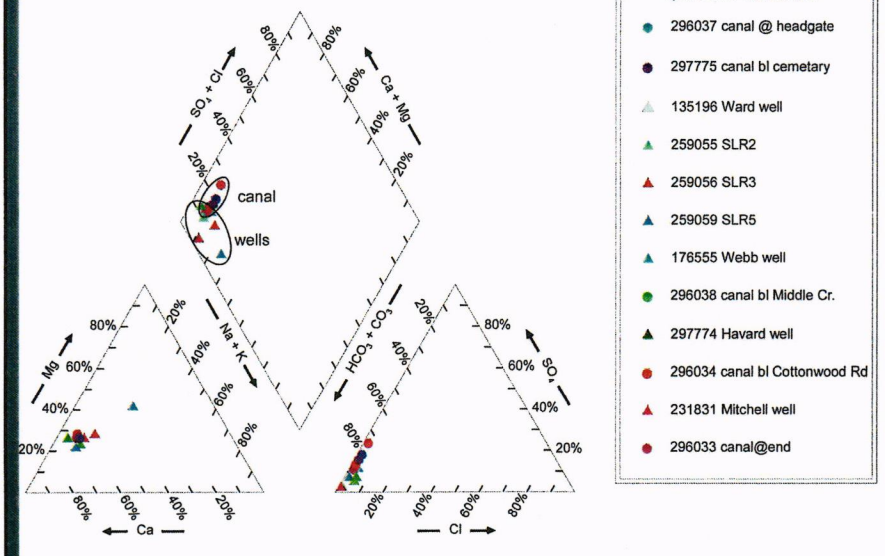


MBMG

DATA REDUCTION – WATER CHEMISTRY

MBMG

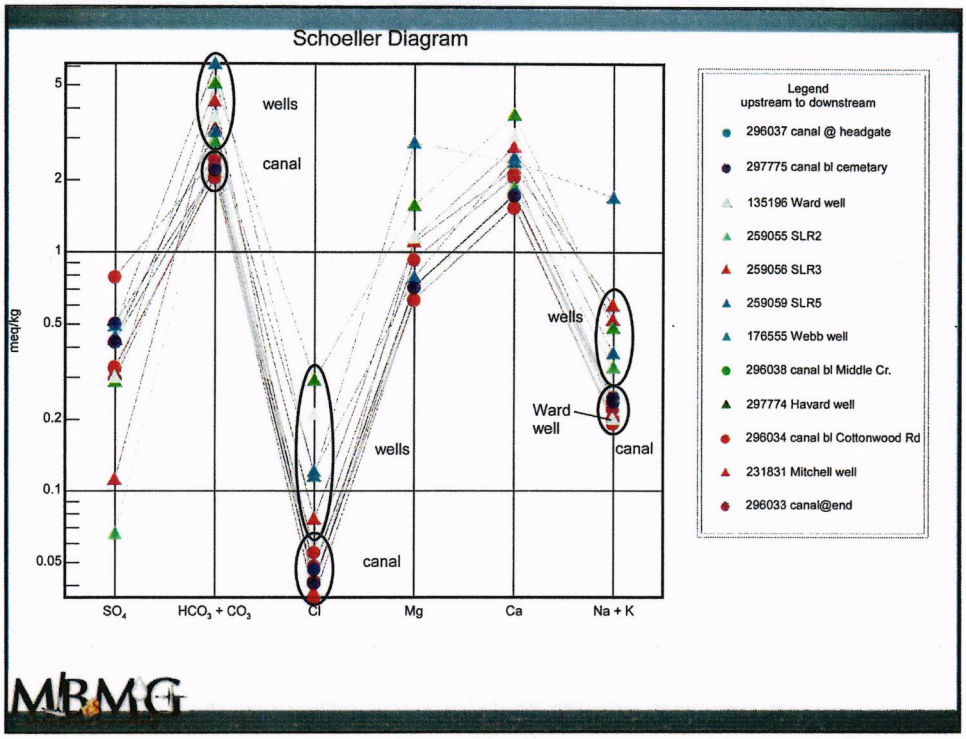
Piper Diagram

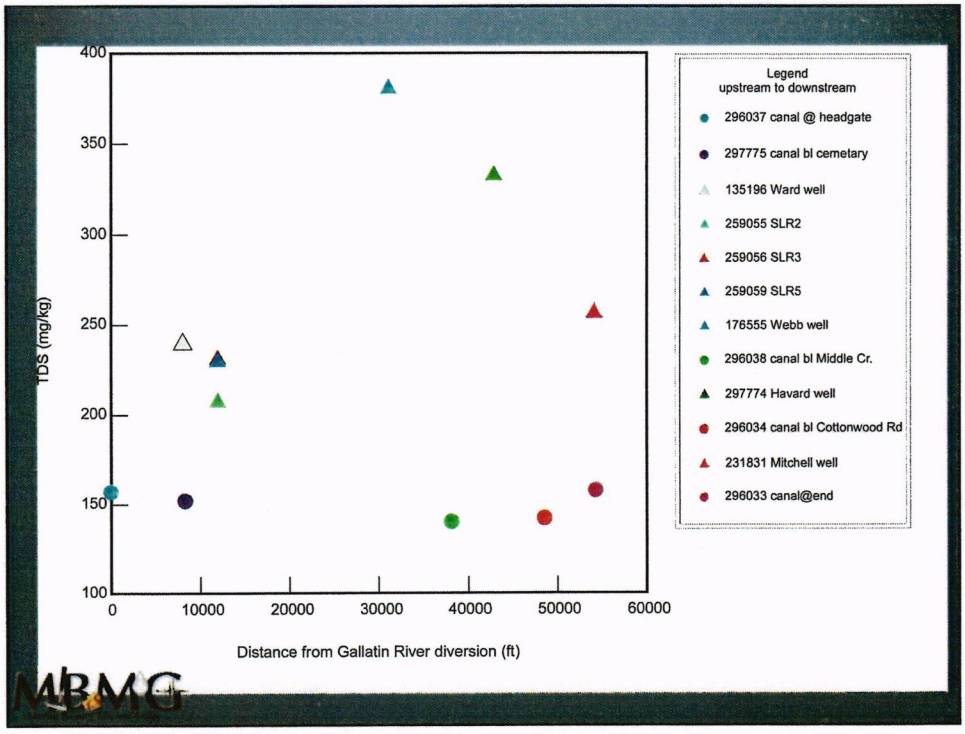


Legend
upstream to downstream

- 296037 canal @ headgate
- 297775 canal bl cemetary
- 135196 Ward well
- 259055 SLR2
- 259056 SLR3
- 259059 SLR5
- 176555 Webb well
- 296038 canal bl Middle Cr.
- 297774 Havard well
- 296034 canal bl Cottonwood Rd
- 231831 Mitchell well
- 296033 canal@end

MBMG


Schoeller Diagram
meq/kg
5
2
1
0.5
0.2
0.1
0.05
wells
canal
wells
canal
wells
Ward well
canal
SO4
HCO3 + CO3
Cl
Mg
Ca
Na + K
Legend
upstream to downstream
296037 canal @ headgate
297775 canal bl cemetary
135196 Ward well
259055 SLR2
259056 SLR3
259059 SLR5
176555 Webb well
296038 canal bl Middle Cr.
297774 Havard well
296034 canal bl Cottonwood Rd
231831 Mitchell well
296033 canal@end


TDS (mg/kg)
400
350
300
250
200
150
100
0
10000
20000
30000
40000
50000
60000
Distance from Gallatin River diversion (ft)
Legend
upstream to downstream
296037 canal @ headgate
297775 canal bl cemetary
135196 Ward well
259055 SLR2
259056 SLR3
259059 SLR5
176555 Webb well
296038 canal bl Middle Cr.
297774 Havard well
296034 canal bl Cottonwood Rd
231831 Mitchell well
296033 canal@end

DATA REDUCTION – LOSS/GAIN CALCULATIONS

6 canal reaches, 4-5 seepage runs, 3 years

Synoptic Run Table of all reaches measured

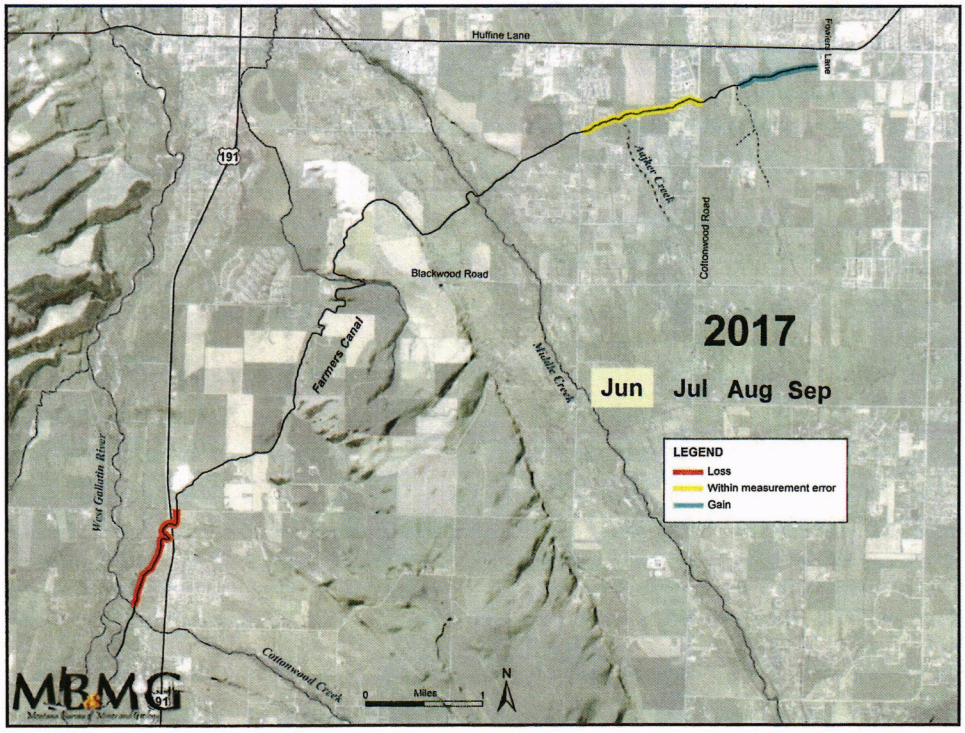
Canal Sections	GWIC Number	Distance	6/8/2017* Gain/Loss	Gain/Loss	8/4/2017* Gain/Loss	9/28/2017 Gain/Loss
		[mi]				
Cottonwood Creek - Blackwood Rd	295970 - 295974	4.43				
Blackwood Rd - Deer Dry Creek	295974 - 295975	1.49				
Check Headgate - Gooch Hill Rd	296038 - 297879	0.87				
Gooch Hill Road - Cottonwood Rd	297879 - 296034	1.11				
Cottonwood Pipe - Canal End	296034 - 296035	0.38				
Pipeline Diversion - Canal End	296035 - 296033	0.7				
		mi				
Cottonwood Creek - Blackwood Rd	295970 - 295974	4.43				
Blackwood Rd - Deer Dry Creek	295974 - 295975	1.49				
Check Headgate - Gooch Hill Rd	296038 - 297879	0.87				
Gooch Hill Road - Cottonwood Rd	297879 - 296034	1.11				
Cottonwood Pipe - Canal End	296034 - 296035	0.38				
Pipeline Diversion - Canal End	296035 - 296033	0.7				
		mi				
Cottonwood Creek - Blackwood Rd	295970 - 295974	4.43				
Blackwood Rd - Deer Dry Creek	295974 - 295975	1.49				
Check Headgate - Gooch Hill Rd	296038 - 297879	0.87				
Gooch Hill Road - Cottonwood Rd	297879 - 296034	1.11				
Cottonwood Pipe - Canal End	296034 - 296035	0.38				
Pipeline Diversion - Canal End	296035 - 296033	0.7				

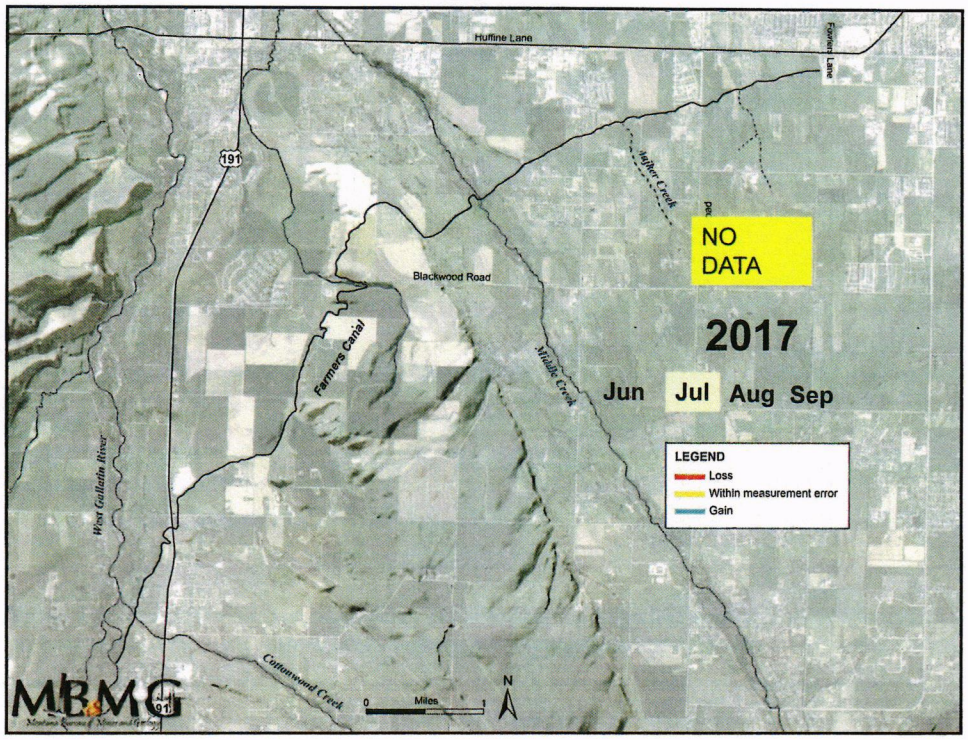
LOSS
GAIN
Value < Error

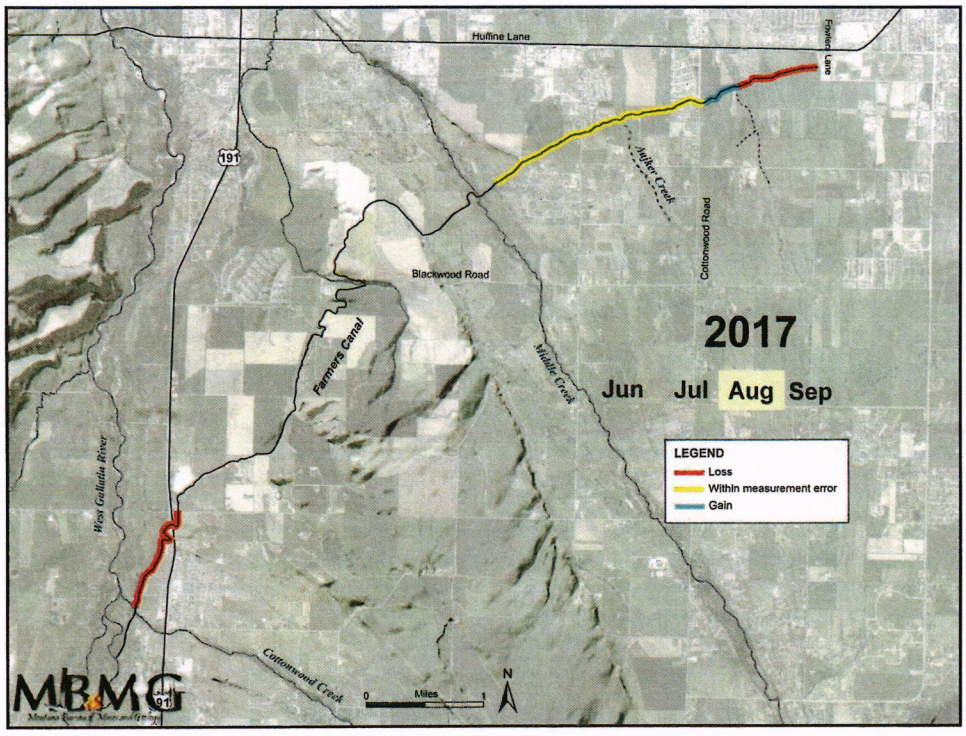
2017

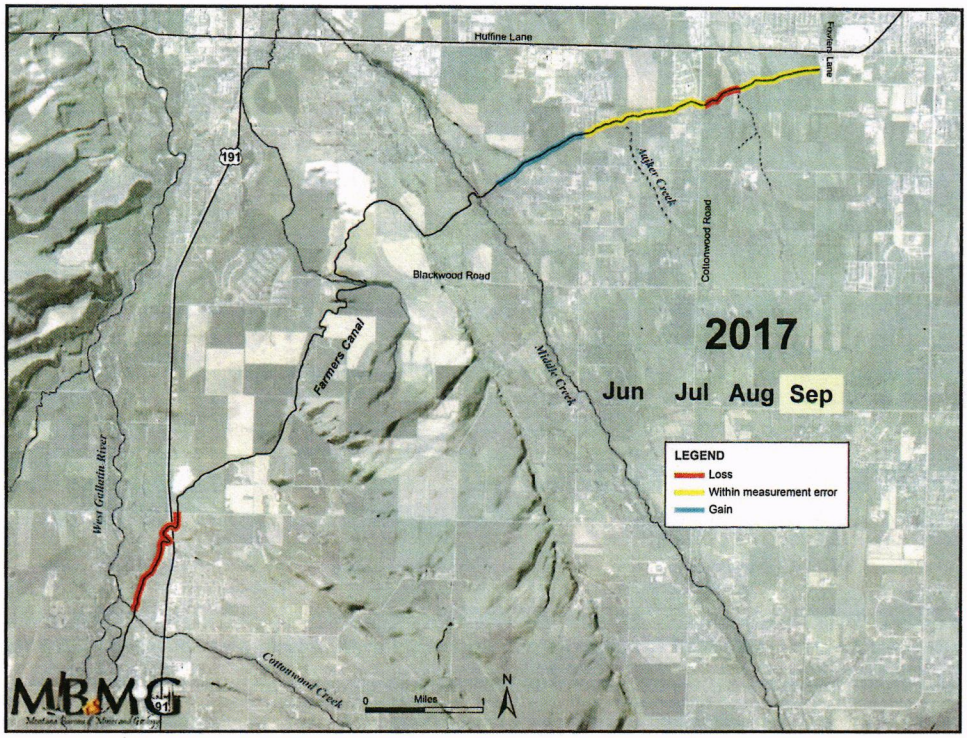
2018

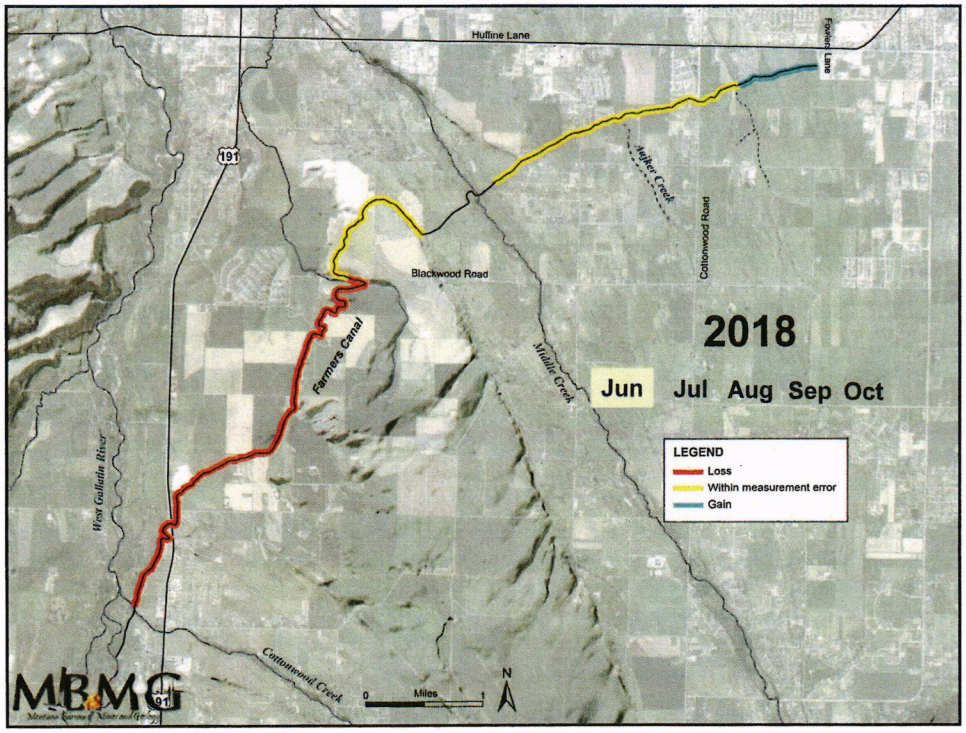
2019

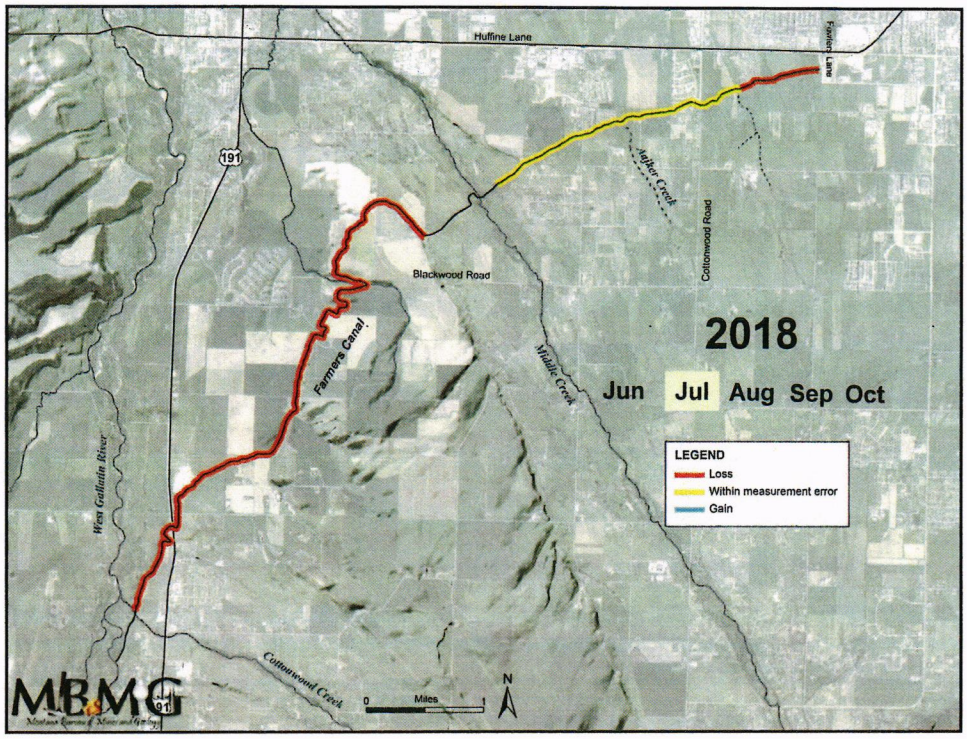


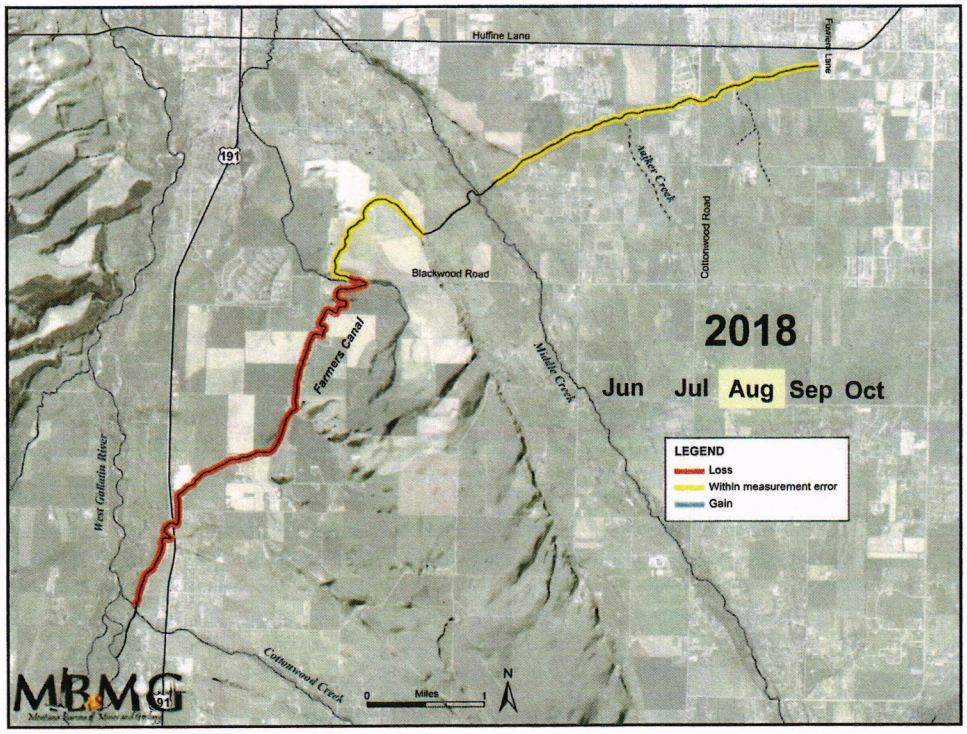

Huffine Lane
Fourier Lane
191
Jaffee Creek
NO
DATA
Blackwood Road
2017
Farmers Canal
Middle Creek
Jun Jul Aug Sep
West Gallatin River
LEGEND
Loss
Within measurement error
Gain
Cottonwood Creek
0
Miles
N
MBMG

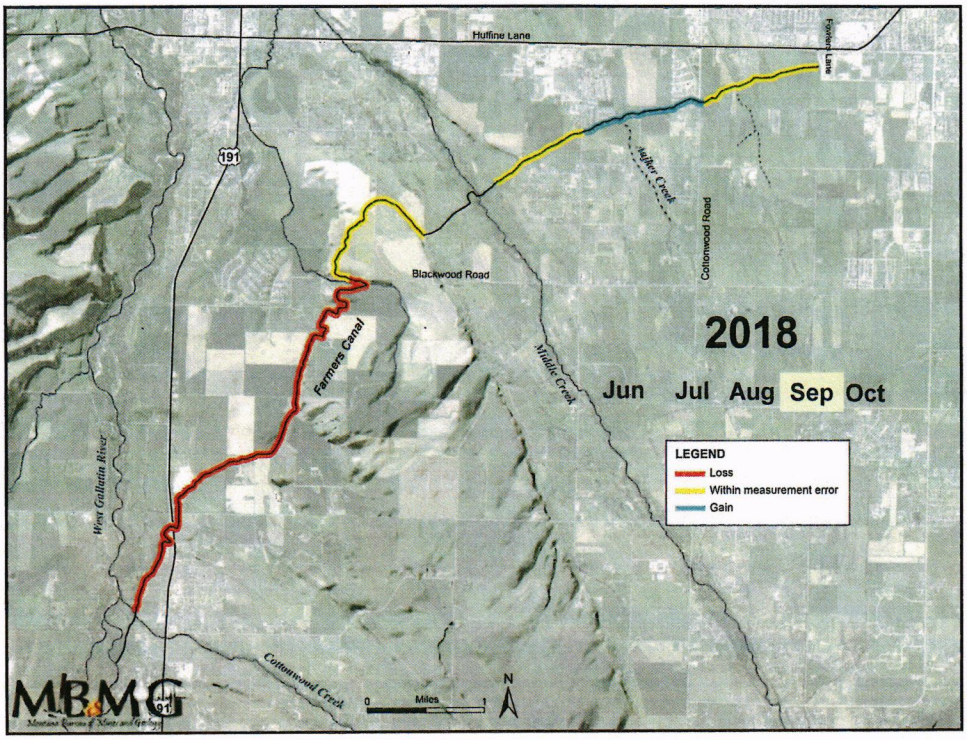

Huffine Lane
Fourier Lane
191
Jaffee Creek
Cottonwood Road
Blackwood Road
2017
Farmers Canal
Middle Creek
Jun Jul Aug Sep
West Gallatin River
LEGEND
Loss
Within measurement error
Gain
Cottonwood Creek
0
Miles
N
MBMG

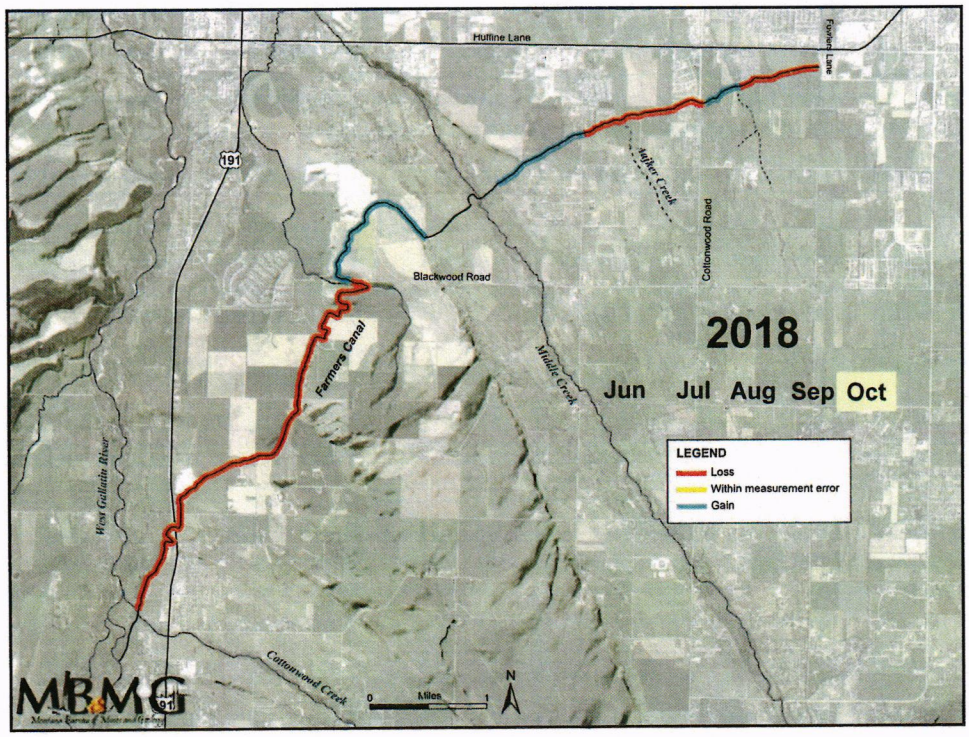

Huffine Lane
Fowler Lane
191
Antelope Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2017
Jun Jul Aug Sep
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles 1
N

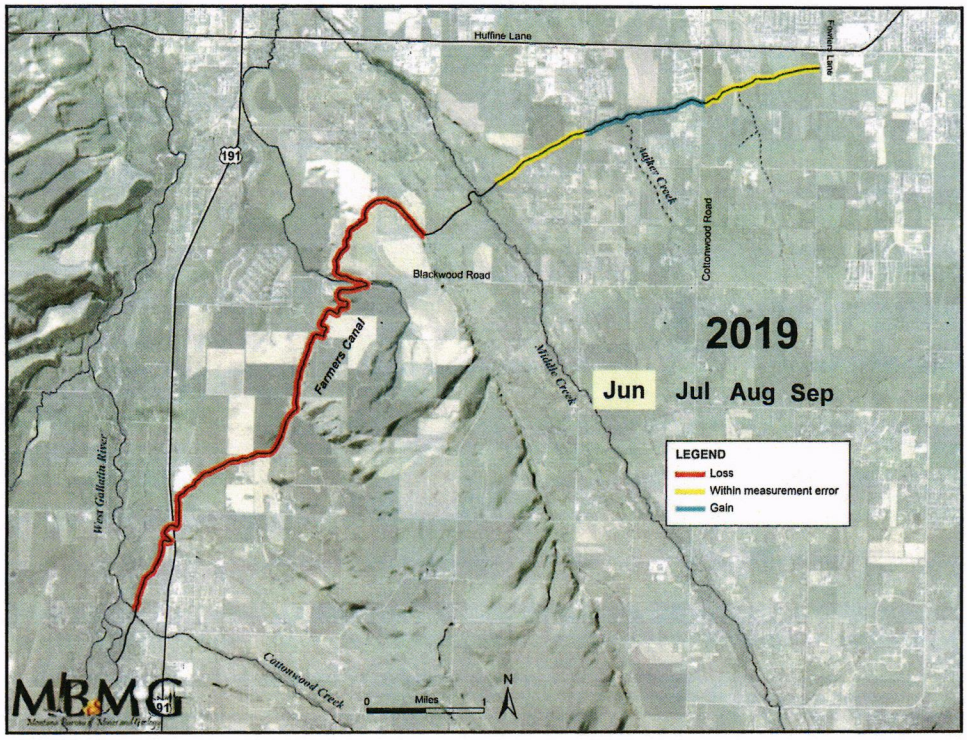

Huffine Lane
Fowler Lane
191
Antelope Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2018
Jun Jul Aug Sep Oct
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles 1
N

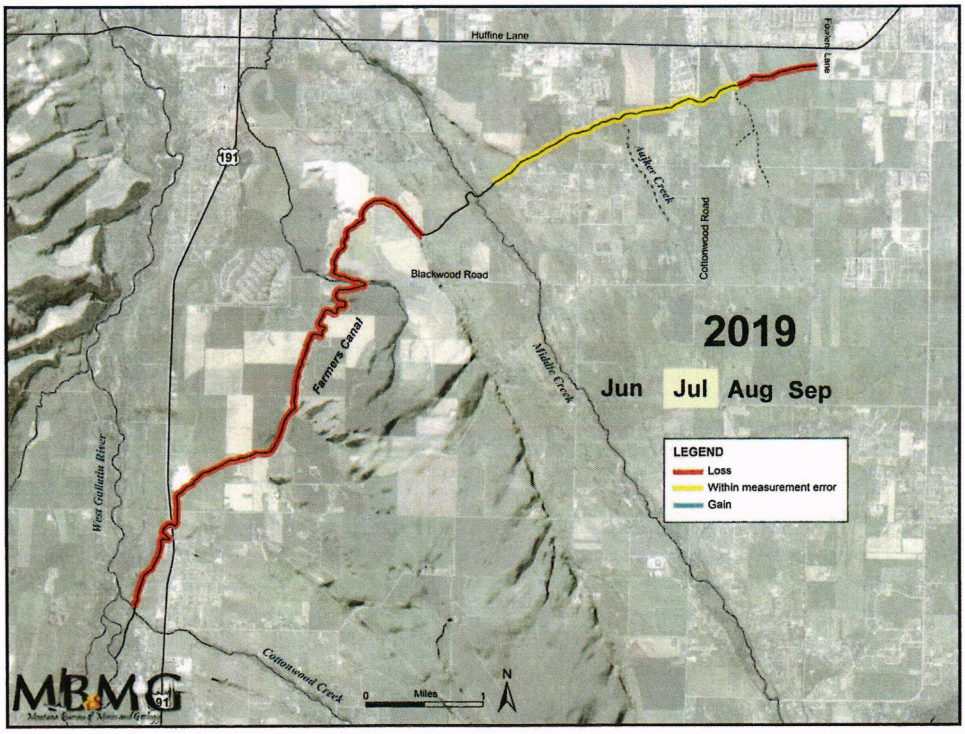

Huffine Lane
Foster Lane
191
Jaeger Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2018
Jun Jul Aug Sep Oct
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles
N

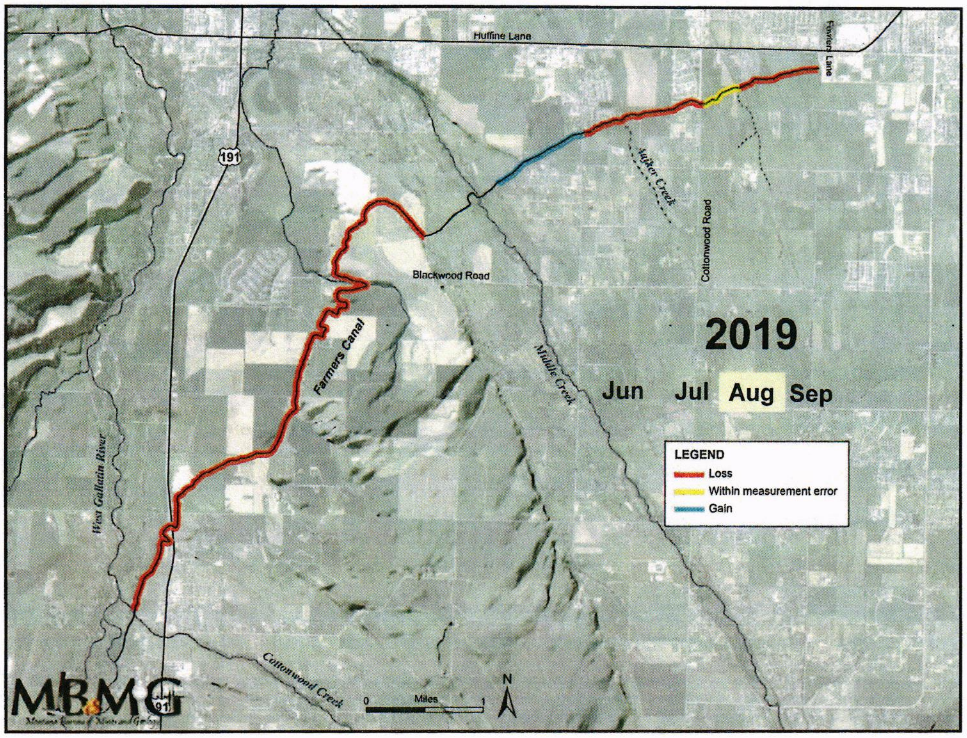

Huffine Lane
Foster Lane
191
Jaeger Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2018
Jun Jul Aug Sep Oct
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles
N

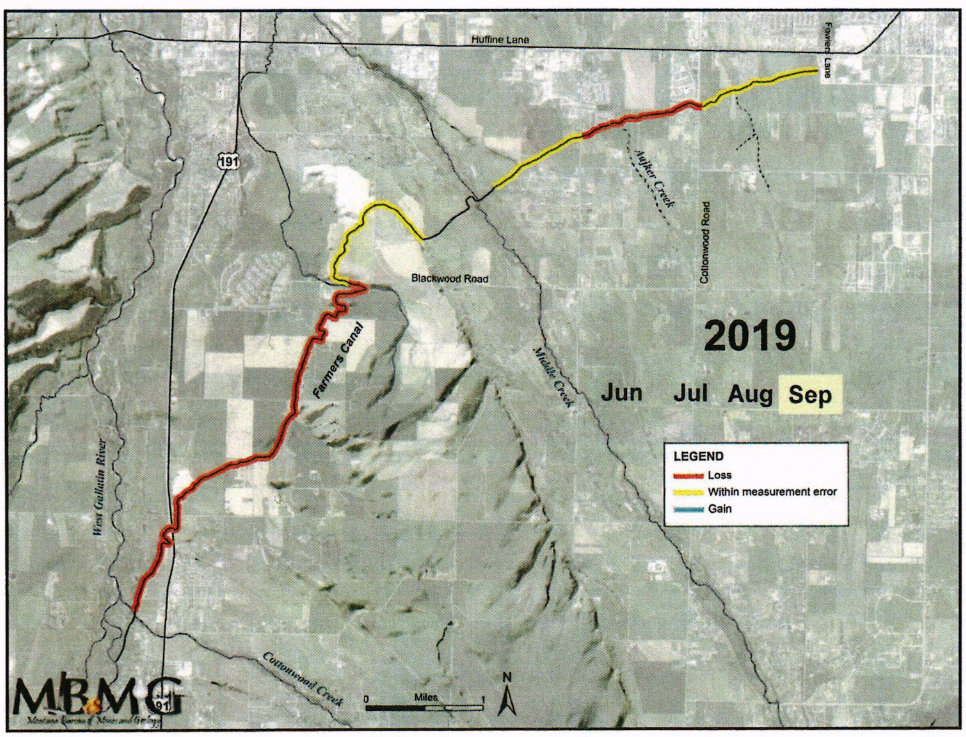

Huffine Lane
Fowler Lane
191
Helper Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
2018
Jun Jul Aug Sep Oct
LEGEND
Loss
Within measurement error
Gain
West Gallatin River
Cottonwood Creek
MBMG
0 Miles 1
N


Huffine Lane
Fowler Lane
191
Helper Creek
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
2018
Jun Jul Aug Sep Oct
LEGEND
Loss
Within measurement error
Gain
West Gallatin River
Cottonwood Creek
MBMG
0 Miles 1
N


Huffine Lane
Fowlers Lane
191
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2019
Jun Jul Aug Sep
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles 1
N


Huffine Lane
Fowlers Lane
191
Cottonwood Road
Blackwood Road
Farmers Canal
Middle Creek
West Gallatin River
Cottonwood Creek
2019
Jun Jul Aug Sep
LEGEND
Loss
Within measurement error
Gain
MBMG
0 Miles 1
N


Huffine Lane
Fowler Lane
191
Aajker Creek
Cottonwood Road
Blackwood Road
2019
Jun Jul Aug Sep
Farmers Canal
Middle Creek
LEGEND
Loss
Within measurement error
Gain
West Gallatin River
Cottonwood Creek
MBMG
Montana Bureau of Mines and Geology
0 Miles 1
N


Huffine Lane
Fowler Lane
191
Aajker Creek
Cottonwood Road
Blackwood Road
2019
Jun Jul Aug Sep
Farmers Canal
Middle Creek
LEGEND
Loss
Within measurement error
Gain
West Gallatin River
Cottonwood Creek
MBMG
Montana Bureau of Mines and Geology
0 Miles 1
N

RESULTS - SUMMARY

Purpose

- Design water management options to improve canal efficiency
  - consider unintended consequences (eg groundwater recharge)

Results

- infrastructure improvements
  - repairs, upgrades to control structures
  - piping
- canal lining
  - specified reaches with specified targets
    - supported by preliminary estimates of sw/gw change

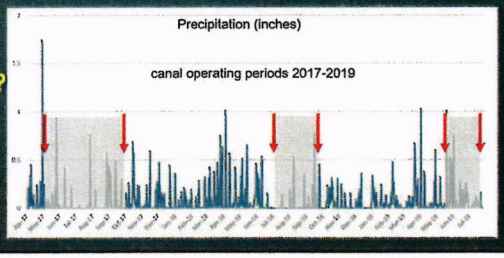
RESULTS - SUMMARY

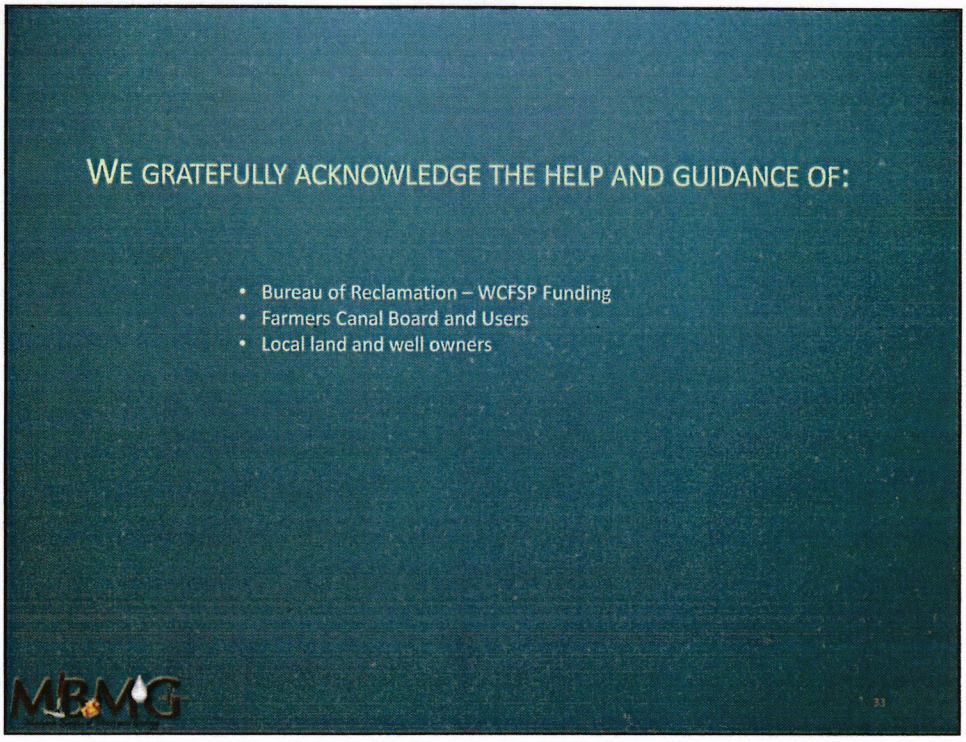
Results

- a first-hand look at the effect of climate change on irrigation
  (our observations were made with minimal changes in operations)

• irrigation demand	Climate controls
• canal efficiency	Physical controls
• resource availability	Legal controls

Which one can the irrigator control?




WE GRATEFULLY ACKNOWLEDGE THE HELP AND GUIDANCE OF:
• Bureau of Reclamation – WCFSP Funding
• Farmers Canal Board and Users
• Local land and well owners
MBMG
33